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# Is Rice Becoming an Inferior Good?

## Food Demand in the Philippines

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Improving pricing and trade policy for cereals, feed, and meat in the Philippines may be more cost-effective in improving the balance of food supply and demand than further investments in rice irrigation — particularly if wheat consumption increasingly substitutes for rice consumption.

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This paper — a product of the International Trade Division, International Economics Department — is part of a larger effort in PRE to understand the changes in food markets in developing countries. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Pauline Kokila, room S7-040, extension 33716 (25 pages, with tables).

Using time-series data, Ingco estimates a demand system model for food — including rice, corn, wheat, meat, fish, and fruits and vegetables — for the Philippines. She finds that:

• Food demand is responsive to relative price changes. Most of the other food products are particularly responsive to changes in rice prices, an important variable in agricultural policy in the Philippines. A marked change in rice prices relative to other food prices would have important policy implications because of its relatively large share in food budgets and the relatively great response of other foods to changes in rice prices.

• In particular, as wheat prices decline, wheat consumption should increase — resulting in some substitution away from rice — because wheat and rice are net substitutes.

• The demand for wheat, meat, and fruits and vegetables is more responsive to own-price changes than are the staple foodstuffs.

• Rice, corn, wheat, a... meat are net substitutes. Rice, fish, and fruits and vegetables are net complements. Wheat is a net substitute for rice, corn, fish, and fruits and vegetables — but a net complement to meat (partly because of urbanization and the proliferation of fast-food outlets in recent years).

• Urbanization increases the consumption of wheat, fish, and fruits and vegetables — and slightly decreases the consumption of rice.

• Consumption of rice and wheat can be expected to grow. Per capita consumption of corn should decline slightly.

• These trends should be considered in evaluating the costs and benefits of further irrigation investments in the rice sector. An improved pricing and trade policy in the cereals, feed, and livestock-meat sectors may be more cost-effective in improving the balance of food supply and demand than more investments in rice irrigation.

# IS RICE BECOMING AN INFERIOR GOOD?
# FOOD DEMAND IN THE PHILIPPINES

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# IS RICE BECOMING AN INFERIOR GOOD? FOOD DEMAND IN THE PHILIPPINES

## I. Introduction

1.1 What are the prospects for demand for the main foodstuffs, particularly rice, in the Philippines? Countries which have traditionally consumed rice as the basic staple such as Japan, the Republic of Korea, and Taiwan are eating more wheat and wheat products. There is also a shift towards increased consumption of meats, dairy products, vegetable oils, and fruits and vegetables. A recent study found rice to be an inferior good in Japan, Taiwan, Malaysia, Singapore, Thailand, and Nepal (Ito, et al 1989). Estimates of income elasticities for rice give conflicting results, but the study by Ito has caused a controversy. The income elasticity estimates by Ito *et al* based on time-series analysis are very low for 14 Asian countries and show significant decline from 1961 to 1984. Based on these results, Ito *et al* argue that there may be potential for an excess supply of rice in Asia.

1.2 Bouis (1989) has challenged these findings and argued that changing economic and production structures, such as the increasing commercialization of production, and not changing income may have resulted in declining rice consumption. Bouis argues that failure to account for the effects on demand for staples of decisions by semi-subsistence farmers to produce staples will lead to a downward bias in income elasticities.

1.3 Huang (1990) has also argued that Ito *et al's* results are generally implausible and noted statistical problems which may have led to underestimation of the income elasticities. Huang's study of demand for cereals in Asia using time-series data shows that for Asia as a whole, total cereal grains are a normal good with an income elasticity of 0.32. Among the nine countries studied, rice is found to be a normal good except in Japan and Thailand. The rice income elasticity estimates are as follows[1]: India (0.527), Pakistan (0.486), Indonesia (0.471), Republic of Korea (0.456), China (0.427), Bangladesh (0.379), Taiwan (0.258), Philippines (0.247), Japan (-0.214), and Thailand (-0.136).

1.4 However, the manner in which food demand parameters have been estimated for most developing countries makes them of limited use for policy analysis for the following reasons. First, most of these estimates are based on ad-hoc demand models, and hence lack consistency with consumer demand theory making comparability difficult. Second, most studies estimate only the demand parameters for staple cereals. No systematic linkages to demand of other foods, such as meat, fish, and other major food items in the diet have been estimated.

1.5 Changing government policies is usually a delicate task and therefore it is desirable for policy makers to anticipate correctly responses to any changes. In most developing countries, the part of the populations most affected by agricultural policy changes are usually near subsistence and, moreover, many consumers of food are also producers. An important set of parameters that determines the effects of policy changes is the matrix of consumer demand elasticities. Consistent measures of income, own-price, and cross-price elasticities for major food items are necessary, therefore, to evaluate adequately the effects of changes in agricultural and incomes policies.

[1] Huang's study assumed weak separability of the cereals group and applied two-stage budgeting using the linear Almost Ideal Demand System (LA/AIDS) by Deaton and Muellbauer (1980). These elasticities are product of income elasticity of total cereals derived in the first-stage and the income elasticity of rice with respect to cereal expenditure in the second-stage.

1.6 In the case of the Philippines, previous studies of food demand using the systems approach have assumed separability of the group[2] (e.g. cereals). For instance, a cereal group defined to include rice, wheat, and maize or a meat group consisting of beef, poultry, and pork. In the case of the cereal group, the separability assumption implies that the demand for cereals is independent of the demand for other food in the diet and other goods outside the cereal group. In other words, the prices of other foods are assumed to be either (a) uncorrelated with cereal prices and cereal expenditure or (b) irrelevant in the cereal demand equation. However, while it simplifies empirical analysis, this assumption has important implications for the elasticity estimates, economic interpretation, predictive performance of demand equations and hypothesis testing.

1.7 Whether or not it is appropriate to assume separability is an empirical question. If the separability assumption is rejected, then the elasticities derived from the system estimated under this assumption will be biased. Intuitively, the marginal rate of substitution between rice and corn is not independent of the level of other major foods in the diet, such as meat or fish and vice-versa. Hence, the true structure of demand may violate the assumption of strong or even weak separability.

1.8 In this paper, the demand for cereals in the Philippines is analyzed. Instead of assuming separability, an alternative specification of the linear Almost Ideal Demand System (LA/AIDS) which includes rice, wheat, maize, meat, fish, fruits and vegetables, other foods, and non-food commodities for the Philippines is estimated using time-series data from 1961 to 1988.[3] The effects of urbanization and dynamic factors such as habit formation in consumption are also considered in the empirical analysis. This study complements Bouis's (1989) study which includes the same set of commodities but uses cross-section data from the 1978 Philippine nationwide nutrition survey. The effects of semi-subsistence production of cereals on consumption as described in Bouis's analysis of household cross-section data is also considered.

1.9 To test separability, non-nested hypothesis testing procedures are used. Alternative specifications of the demand system are evaluated based on goodness-of-fit, predictive performance, and bias in elasticity estimates. Since elasticities may not be constant over time, estimates over the period of the study are presented, in addition to the estimates based on the means of the observations.

1.10 The outline of the paper is as follows: the demand system is described in the next section. The various specifications are estimated using aggregated annual time-series and the tests are implemented. Then using the estimated parameters, the demand and income elasticities are estimated over the sample period. The parameters are used to generate baseline projections of cereal demand to 2000. Some policy implications and concluding remarks are given in the final section.

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[2] Data limitations often prevent explicitly including all prices in a demand model, so the assumption of weak separability is used to reduce the number of prices which must be included in empirical analysis.

[3] Changes in food expenditures by income group or by region are not accounted for in this study, given the aggregated time-series data. The effects of income levels and other demographic variables on consumption are analyzed in the cross-section study by Bouis (1989), which used the 1978 Nutrition Survey. For the purpose of evaluating aggregate demand prospects, aggregated time-series analysis is adequate. This study also aims to investigate the patterns in income and demand elasticities over time, thus requiring the use of time-series data.

## II. Food Demand System for the Philippines

### II.1 Demand Model

2.1 Among the empirical demand systems applied in the literature, the Almost Ideal Demand System (AIDS) (Deaton and Muellbauer, 1980) has provided the most robust estimates. This model combines the best of the theoretical features of both the translog and Rotterdam models. Food consumption behavior in the Philippines is analyzed by estimating a complete food demand system using a linear version of the AIDS model. The resulting parameter estimates are used to derive expenditure or income elasticities, own-price, and cross-price elasticities. The theoretical restrictions of adding-up, homogeneity, and Slutsky symmetry are imposed and tested.

2.2 An estimable variant of the Almost Ideal Demand System with the addition of dynamic factors can be specified as

$$w_{it} = \alpha_i + \Sigma_j \ \gamma_{ij} \ \ln P_{jt} + \beta_i \ln (Y_t/P_t) + \delta_i \ln Z_t + U_{it} \tag{1}$$

$$i,j = 1,\ldots, n \text{ commodities}$$

where $w_{it}$ is the average budget share of the ith commodity in time t, $P_{jt}$ is the jth commodity price at time t, $Y_t$ is per capita expenditure, $P_t$ is an aggregate price index, and Z represents dynamic factors. $\alpha$, $\gamma$, $\beta$, and $\delta$ are parameters to be estimated.

The aggregate price ($P_t$), used to normalize nominal per capita expenditure ($Y_t$), is defined as,

$$\ln P_t = \alpha_o + \Sigma \ \alpha_j \ \ln P_{jt} + ½ \ \Sigma \ \Sigma \ \gamma_{ij} \ \ln P_{it} \ \ln P_{jt} \tag{2}$$

The Stone (1954) price index, $\ln P_t = \Sigma \ w_{it} \ \ln P_{it}$, is used to approximate (2). For the demand system to conform to consumer demand theory, the structural parameters are further constrained to satisfy the following conditions:

Adding-up condition, Engel Aggregation: $\Sigma \ \alpha_i = 1, \quad \Sigma \ \beta_i = 0,$

$$\Sigma \ \gamma_{ij} = 0; \tag{3}$$

$$\text{Homogeneity:} \quad \Sigma \ \gamma_{ij} = \theta_i = 0; \tag{4}$$

$$\text{Symmetry:} \quad \gamma_{ij} = \gamma_{ji} \tag{5}$$

2.3 Condition (3) is the budget exhaustion condition for a given income which implies that the sum of the weighted income elasticities adds to unity. Thus, only n-1 of the income elasticities are independent. Condition (4) means that the demand functions are homogenous of degree zero in prices and income. That is, an equal proportional change in prices and income will leave commodity demands unchanged.

2.4 The AIDS specification has several advantages for analyzing demand for food in developing countries. First, in contrast to other functional forms of demand systems, such as the Linear Expenditure System, the AIDS is flexible enough to closely approximate demand elasticities at particular data points. Also, the possibility of inferior commodities is allowed.

2.5 The effects of urbanization on demand is tested by including the percentage of the population in urban cities. To account for the separate effects of changes in production structure on consumption, Bouis (1990) estimated separate demand equations for rice-consuming regions and corn-consuming semi-subsistence households using cross-section data. Bouis noted that household survey data for the Philippines show that semi-subsistence producers of a staple tend to be heavy consumers of that staple. Hence, declines (increases) in staple consumption may not be a result of income changes per se, but may be due to declines (increases) in semi-subsistence production of that staple. Corn consumption in the Philippines has increased with increases in semi-subsistence corn production. In this time-series analysis, the effects of changes in semi-subsistence farming on corn production is proxied by adding a shifter variable to represent the proportion of "corn-consumers" in the population.[4]

## II.2 Data Description

2.6 The data needed to estimate the parameters for the commodity budget share equations include per capita expenditures, prices, and per capita consumption. The data come from several sources. Data for domestic food consumption for each commodity are taken from the FAO Supply and Utilization Accounts Database. Data from the FAO provides a consistent time-series back to 1961. The data from the Philippines Bureau of Agricultural Statistics (BAS) covers only the calendar years 1978-89. Some difficulties were encountered in combining the BAS data on food consumption with that from the former Integrated Agricultural Production and Marketing Project in the Ministry of Agriculture since the latter were on a crop years basis. The price data are taken from several sources. The price data from BAS were combined with data from the National Statistics Office (NSO) and the Central Bank. Total personal consumption expenditure is used as the income variable and is taken from the national income accounts prepared by the National Economic Development Authority. Population data were taken from the Bureau of Census. The number of "corn-consumers" is proxied by population in Cagayan, Western and Eastern Visayas, and Northern and Southern Mindanao.

## II.3 Estimation Procedure

2.7 To estimate the parameters of the budget share equations, additive disturbances are postulated. The disturbances ($U_i$) for each equation are assumed to satisfy the standard assumptions of normality, zero mean, and constant variance. Because of possible interactions of expenditures on commodities within the system, the error terms across equations are assumed to be contemporaneously correlated. Since the budget shares sum to one and the disturbances must sum to zero across commodities for each observation, the covariance matrix for the original disturbances is thus singular. Hence, the budget share equation for "other goods" (non-food) is arbitrarily deleted and the non-linear Zellner estimation procedure is applied to the remaining budget share equations. The iterative Zellner estimation is invariant to whichever budget share equation is deleted and asymptotically equivalent to the maximum likelihood estimation.

[4] An indirect measure of subsistence agriculture can be derived by estimating the value of consumption that is not included in the national accounts.

2.8 The monotonicity condition is equivalent to requiring the budget share equations to be non-negative. The quasi-convexity condition is equivalent to requiring the NxN matrix of Slutsky price derivatives to be negative semi-definite. Neither one of these conditions is imposed directly in estimation, but they are verified by checking the estimated parameters at selected data points.

## III. Empirical Results

### III.1 Food Demand System

3.1 The variables included in equation (1) were defined to agree with per capita total consumption expenditure. That is, the average shares of total expenditures were used as the dependent variables. Alternative ways of incorporating "other goods" in the system were considered by first, deflating all prices using the consumer price index for all goods, and second, by including an index of prices of other items (excluding food) as a separate explanatory variable. The first specification is usually preferred to save degrees of freedom. The estimation was carried out with aggregation, homogeneity, and symmetry restrictions imposed. The structural parameters as well as the elasticities are evaluated and compared with similar system estimates from other studies.

3.2 Results of estimation of the demand system for cereals under the separability assumption gives poor statistical properties. The Durbin-Watson statistic shows autocorrelation in the demand for rice and corn, indicating model mis-specification. In general, the alternative model which includes other major items as well as other goods gives better statistical properties. The parameter estimates for the alternative model are shown in Table 1.

3.3 Most of the estimated demand coefficients have t-values that are equal to or greater than 2.0, indicating that the budget shares for each commodity are responsive to prices and income. The food budget shares are strongly responsive to own-prices and real per capita expenditure. The nature of the demand for food commodities can be directly inferred from the signs of the structural parameters. Commodities with negative expenditure parameters ($\beta_i < 0$) have income elasticities less than unity, and those with positive parameters ($\beta_i > 0$) have income elasticities greater than unity. Commodities with positive own-price parameters ($\gamma_{ii} > 0$) are price inelastic and those with negative parameters ($\gamma_{ii} < 0$) are price elastic.

3.4 Own-prices in the main have positive marginal effects on the budget shares. For the shares to increase with increases in the own-price, the proportionate change in quantity demanded had to be less than the proportionate change in own-price, given the level of income. Own-price elasticities for these food commodities were expected to be less than unity. The number of "corn-consumers" has a positive effect on corn food consumption. Urbanization, as measured by the proportion of the population in urban areas, has a positive effect on the consumption of wheat, fish, and fruits and vegetables and a small negative effect on rice consumption. Habit formation, specified by including lagged consumption, is found to have a small positive effect on consumption of rice, but did not have significant effect on the other commodities.

Table 1: Parameter Estimates for the LA/AIDS Model, Homogeneity and Symmetry Imposed.

| | | Prices | | | | | | | | | | | Summary Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equation | Intercept | Rice | Corn | Wheat | Meat | Fish | Fr & Veg | Other Goods | Total Expenditure | Urbani-zation | Habit Formation | Proportion Of "Corn-Consumers" | SSE | R2 | DW |
| Rice | 0.0782 | 0.0285 | 0.0029 | 0.0051 | 0.0008 | -0.00313 | -0.0152 | -0.0190 | -0.0261 | -0.0001 | 0.0008 | | 0.0001 | 0.88 | 1.74 |
| | (2.37) | (4.72) | (0.84) | (2.47) | (1.5) | (-0.98) | (-4.35) | | (-2.19) | (-1.155) | (2.61) | | | | |
| Corn | 0.0151 | 0.0029 | 0.0121 | 0.0025 | 0.0092 | 0.0088 | -0.0007 | -0.0348 | -0.0161 | | | 0.0003 | 2.53E-05 | 0.88 | 1.65 |
| | (1.6) | (0.84) | (3.01) | (1.48) | (1.71) | (3.3) | (-1.1) | | (-1.26) | | | (1.92) | | | |
| Wheat | 0.0093 | 0.0051 | 0.0025 | 0.0024 | -0.0029 | 0.0026 | 0.0003 | -0.0100 | -0.0024 | 7.96E-05 | | | 5.26E-06 | 0.61 | 2.50 |
| | (1.1) | (2.47) | (1.5) | (1.7) | (-1.02) | (2.56) | (1.28) | | (-1.6) | (1.33) | | | | | |
| Meat | 0.0077 | 0.0008 | 0.0092 | -0.0029 | -0.0014 | 0.0044 | 0.0019 | -0.0120 | -0.0037 | 5.71E-04 | | | 7.79E-06 | 0.65 | 1.30 |
| | (1.05) | (1.5) | (1.7) | (-1.02) | (3.27) | (1.88) | (1.33) | | (-1.38) | (1.59) | | | | | |
| Fish | 0.0102 | -0.00313 | 0.0088 | 0.0026 | 0.0044 | 0.0101 | 0.0051 | -0.0278 | -0.0007 | 4.03E-06 | | | 1.11E-05 | 0.94 | 1.50 |
| | (1.71) | (0.98) | (3.3) | (2.56) | (1.88) | (3.34) | (2.38) | | (-1.14) | (1.05) | | | | | |
| Fruits & Veg | 0.0266 | -0.0152 | -0.0007 | 0.0003 | 0.0019 | 0.0051 | 0.0155 | -0.0069 | -0.0054 | 0.0004 | | | 2.63E-05 | 0.97 | 1.53 |
| | (0.96) | (-4.35) | (-1.1) | (1.28) | (1.33) | (2.38) | (3.84) | | (-1.49) | (2.5) | | | | | |

t-values are in parenthesis.

### III.2 Testing of Restrictions[5]

3.5 The demand system model described above may be expressed more compactly as

$$W_t = \Gamma X_t + U_t \tag{6}$$

where $W_t$ is a vector of the shares, $X_t$ is a vector of explanatory variables, $\Gamma$ is the matrix of preference parameters, and $U_t$ is a vector of random disturbances. The theoretical restrictions to be tested are expressed in terms of the elements of the matrix $\Gamma$. The elements of the matrix $X_t$ are assumed exogenous.[6]

3.6 $U_t$ is assumed to be distributed normally with covariance matrix $\Omega$. As noted above, $\Omega$ is singular due to the additivity contraint; hence, the nth equation (other goods) is deleted in the estimation which renders the resulting (n-1)x(n-1) covariance matrix nonsingular. To test the restrictions, the log-likelihoods for the restricted and unrestricted models may be calculated and the null hypothesis is tested using the likelihood ratio test as follows

$$T^1 = -2 \ ( \log L^r - \log L^u ), \tag{7}$$

where $\log L^r$ and $\log L^u$ are the maximized log-likelihood values with and without the restrictions imposed, respectively. Although the likelihood ratio test is asymptotically most powerful, properties in small samples are often difficult to define. Small-sample distributions are usually characterized to have more mass in the tails than the corresponding limit distributions, so that the use of the asymptotic criteria leads to a bias towards rejection of the null hypothesis in small samples. Meisner (1979) has shown that tests based on (6) are biased towards rejection of the null hypothesis. Baldwin et al (1983) and Chambers (1990) proposed the use of adjusted statistics to attempt to correct this bias in finite samples. Following Baldwin et al and Chambers, the following statistics are also used in testing the restrictions:

$$T^2 = T \ \mathrm{tr}( \Omega^r )^{-1} \ (\Omega^r - \Omega^u), \tag{8}$$

$$T^3 = \frac{\mathrm{tr}(\Omega^r)^{-1} \ (\Omega^r - \Omega^u)/q}{\mathrm{tr}(\Omega^r)^{-1} \ \Omega^u \ /(n-1)(T-K)}, \tag{9}$$

$$T^4 = \frac{\mathrm{tr}(\Omega^r)^{-1} \ (\Omega^r - \Omega^u)}{\phantom{x}}, \tag{10}$$

[5] Material in this section was based from Chambers (1990).

[6] Given the use of aggregate data, this assumption may not hold in practice. However, Attfield (1985) has shown that "a model in which homogeneity is tested with expenditure assumed exogenous is exactly equivalent to a model in which the exogeneity of expenditure is tested with homogeneity imposed". He also noted that earlier studies which have rejected homogeneity could be interpreted as rejecting the exogeneity of expenditure under assumed homogeneity. It would be interesting to test whether the demand system model estimated rejects homogeneity. If we fail to reject the null hypothesis of homogeneity, then the exogeneity assumption on the elements of $X_t$ is valid.

$$tr(\Omega^r)^{-1}\,\Omega^u\;/(n-1)\,(T-K)$$

where $\Omega^r$ and $\Omega^u$ are the estimated covariance matrices from the models with and without the restrictions, respectively. q refers to the number of restrictions, T is the sample size, and K is the number of explanatory variables. Statistics $T^1$, $T^2$, and $T^4$ are asymptotically distributed as $\chi^2$ with q degrees of freedom under the null hypothesis. $T^3$ has an approximate F distribution with q and (n-1)(T-K) degrees of freedom. These four test statistics were estimated and used to test the null hypotheses of homogeneity and symmetry in the demand models.

3.7 The calculated values of the test statistics are shown in Table 2. The tests indicate the failure to reject homogeneity and symmetry when the alternative statistics are considered. The conclusion therefore is that the restrictions proposed by demand theory are applicable to the commodity groups used in this analysis. In view of these results, it is not unreasonable to impose homogeneity and symmetry on the food demand systems and to assume that the explanatory variables are exogenous.

Table 2: Test Statistics for Homogeneity and Symmetry.

| Test Statistics | Calculated Value | Critical Value significance level 1% | 5% |
|---|---|---|---|
| | 1) Test For Homogeneity | | |
| $T^1$ | | | |
| $T^2$ | 3.336 | 16.812 | 12.592 |
| $T^3$ | 0.219 | 2.960 | 2.180 |
| $T^4$ | 1.311 | 16.812 | 12.592 |
| | 2) Test For Symmetry[1] | | |
| $T^1$ | 16.320 | 30.500 | 24.900 |
| $T^2$ | 6.601 | 30.500 | 24.900 |
| $T^3$ | 0.184 | 2.190 | 1.750 |
| $T^4$ | 2.765 | 30.500 | 24.900 |

[1] The unrestricted model used to test symmetry has homogeneity imposed.

### III.3 Price and Income Elasticities

3.8 The uncompensated (Marshallian) demand elasticities were computed using the following formulae:

income or expenditure elasticity: $\eta_{iy} = \beta_i / w_i + 1$ (6)

own-price elasticity: $\varepsilon_{ii} = \gamma_{ii} / w_i - (1 + \beta_i)$ and (7)

cross-price elasticity: $\varepsilon_{ij} = \gamma_{ij} / w_i - \beta_i ( w_j / w_i )$ (8)

3.9 The income elasticity estimates based on the full model are presented in Table 3. The Marshallian and Hicksian (income-compensated) elasticities based on the sample means are shown in Table 4 and 5. The elasticities over the sample period are also calculated for each commodity and are presented in Appendix tables A1 to A7.

3.10 The income elasticities were less than unity for all commodities. Among the cereals, rice and wheat have positive income elasticities, while corn was found to be an inferior good. The estimates indicate that wheat is preferred over rice. The high-priced foods such as meat, fish, and fruits and vegetables tend to have higher income elasticities than the staple cereals.

3.11 The income elasticities for the three cereals appear to change over time, with the rice income elasticity declining during periods of income growth. The income elasticity of demand for rice and income is plotted in Figure 1. The figure suggests a high negative correlation, with some lagged response, between income and the magnitude of the income elasticity for rice. The income elasticity for rice appears to decline from about 0.44 in the mid-1960s to about 0.18 during the late-1980s. The income elasticity for corn shows the opposite pattern. That is, the values become more negative during periods of increases in incomes and less negative during periods of income declines (1983-85). The income elasticity of demand for wheat does not exhibit any marked change over most of the period. Its magnitude fluctuated around 0.5 in the mid-1960s to mid-1970s, declining slightly to about 0.22 in 1985. After 1985, it slightly increased to 0.6 in 1986 and averaged at 0.51 in 1988-90. Similarly, the income elasticities for meat does not show much change over the period of the study.

3.12 All the uncompensated (Marshallian) own-price elasticities are negative, while most of the compensated cross-price elasticities (Hicksian) are positive (see Appendix). That is, changes in own-price indexes had inverse effects on quantities demanded. All the estimated own-price elasticities are less than unity. Rice and corn, as well as fish are the least responsive to changes in own-prices. In contrast, the demand for wheat, meat, and fruits and vegetables are generally more responsive to own-price changes than the staple cereals, with meat having the largest own-price elasticity. The absolute values of the own-price elasticities tend to move closely with the income elasticities, suggesting that the uncompensated own-price elasticities include substantial income effects.

3.13 The values of the estimated cross-price elasticities suggest that food demand is responsive to relative price changes. Most of the food groups are particularly responsive to changes in rice prices. However, changes in the price indexes of the other food groups had less effect on the demand for rice. This asymmetry in cross-price effects partly reflects the relatively large share of rice in expenditure.

3.14 The demand for rice appears to become less responsive to its own-price over time, with the own-price elasticity declining from about -0.3588 in 1965 to about -0.0819 in 1988. The cross-price elasticity of demand for rice with respect to wheat tends to increase over the period of the study. Its magnitude slightly increased from about 0.12 during the mid-1960s to mid 1970s to about 0.16 during the late-1980s. This suggests that wheat is becoming more of a substitute for rice.

3.15 Wheat demand is the most price-responsive of the cereals, with an own-price elasticity of about -0.45 (at the sample means). Over time, the own-price elasticity of wheat demand has changed slightly, with some declines to about -0.22 in 1985. After 1985, the magnitude appears to return to earlier levels. Wheat demand is very responsive to changes in prices of other cereals, particularly changes in rice prices. It is interesting to note the complementarity between wheat and meat. This is plausible given the tendency towards higher consumption of both meat and wheat flour products (hamburgers, bread and noodles) particularly in restaurants and fast food chains such as MCDonalds, and Jolly Bees, etc.

3.16 The compensated price elasticities, adjusted for changes in real total expenditure (see appendix) suggest that rice, corn, wheat, and meat are net substitutes; rice, fish, and fruits and vegetables are net complements. Wheat is a net substitute for rice, corn, fish, and fruits and vegetables, but a net complement to meat.

Table 3. Income Elasticity of Demand.

| Year | Rice | Corn | Wheat | Meat | Fish | Fruits & Vegetables |
|---|---|---|---|---|---|---|
| 1965-77 | 0.4381 | -0.2901 | 0.4443 | 0.9495 | 1.0969 | 0.6044 |
| 1968-72 | 0.3063 | -0.1249 | 0.5196 | 0.9471 | 1.0666 | 0.6479 |
| 1973-76 | 0.4000 | -0.1504 | 0.5203 | 0.9511 | 1.0522 | 0.7027 |
| 1977-79 | 0.2167 | -0.1469 | 0.4378 | 0.9376 | 1.0596 | 0.7610 |
| 1980-83 | 0.0652 | -0.4102 | 0.3972 | 0.9404 | 1.0562 | 0.7988 |
| 1984-86 | 0.2324 | -0.2403 | 0.4264 | 0.9336 | 1.0580 | 0.7744 |
| 1987-90 | 0.1795 | -0.4546 | 0.4776 | 0.9444 | 1.0600 | 0.7900 |
| At Sample Means | 0.4381 | -0.2901 | 0.4442 | 0.9495 | 1.0969 | 0.6044 |

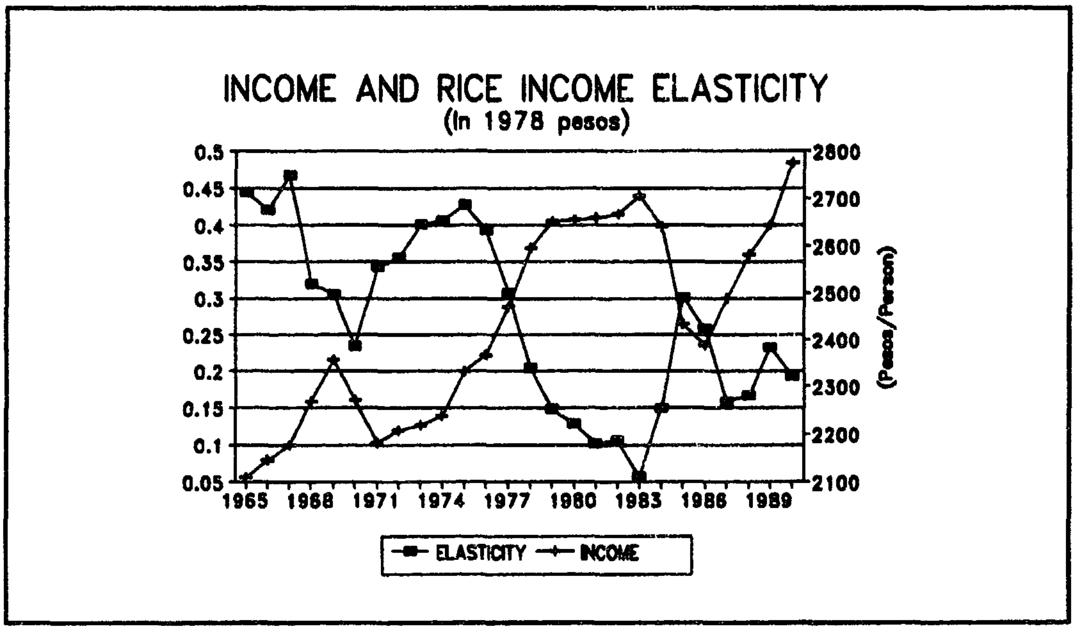
INCOME AND RICE INCOME ELASTICITY
(In 1978 pesos)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
2800
2700
2600
2500
2400
2300
2200
2100
(Pesos/Person)
1965
1968
1971
1974
1977
1980
1983
1986
1989
ELASTICITY
INCOME

**Figure 1**

Table 4. Marshallian (Ordinary) Demand Elasticity Matrix.

| Commodity | With Respect To The Price Of | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Vegetables | |
| Rice | -0.2023 | 0.0882 | 0.1398 | 0.0258 | -0.0773 | -0.3983 | 0.29415 |
| Corn | 0.2646 | -0.0686 | 0.1946 | 0.7022 | 0.6815 | 0.0795 | -0.21245 |
| Wheat | 1.1594 | 0.5904 | -0.4525 | -0.6602 | 0.6012 | 0.0814 | 0.45473 |
| Meat | 0.1218 | 1.4075 | -0.4498 | -1.2101 | 0.6812 | 0.2893 | 0.94378 |
| Fish | -0.3020 | 0.8473 | 0.2524 | 0.4272 | -0.0426 | 0.4826 | 1.06591 |
| Fruits & Veg | -0.7609 | 0.0409 | 0.0171 | 0.0972 | 0.2588 | -0.2096 | 0.72549 |

Elasticities calculated at sample means.

Table 5. Hicksian (Compensated) Demand Elasticity Matrix.

| Commodity | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Vegetables |
| Rice | -0.1914 | 0.0921 | 0.1411 | 0.0277 | -0.0743 | -0.3925 |
| Corn | 0.2568 | -0.0714 | 0.1956 | 0.7008 | 0.6793 | 0.0753 |
| Wheat | 1.1762 | 0.5844 | -0.4505 | -0.6572 | 0.6060 | 0.0904 |
| Meat | 0.1567 | 1.4200 | -0.4456 | -1.2162 | 0.6714 | 0.3080 |
| Fish | -0.2626 | 0.8614 | 0.2571 | 0.4202 | -0.0538 | 0.5037 |
| Fruits & Veg | -0.7341 | 0.0505 | 0.0203 | 0.1019 | 0.2664 | -0.1953 |

Elasticities calculated at the sample means.

## III.4 Comparisons

3.17 Demand elasticities for selected foods from recent studies of the Philippines are given in Table 6. Since these studies vary in terms of data bases, reference periods, definition and aggregation of commodities, demand structure, and method of estimation used, the comparisons must be made cautiously. Nevertheless, if the purpose is to use these estimates for policy analysis, it is important to develop the proper perspective about the signs and order of magnitude of effects. Results of studies by Bouis (1989) and Huang (1990) were selected since they both use demand systems approaches.

Table 6: Income Elasticities from Other Studies

| Commodity | Bouis (1989)[1] | | Huang(1990)[2] |
|---|---|---|---|
| | Urban | Rural | Aggregate |
| Rice | -0.200 | 0.200 | 0.247 |
| Corn | -0.450 | -0.449 | 0.102 |
| Wheat/other cereals | 0.475 | 0.881 | 0.061 |
| Meat | 0.712 | 0.934 | |
| Fish | 0.595 | 0.790 | |
| Fruits & Vegetables | 0.186 | 0.327 | |

[1] Estimates based on cross-section data from 1978 Philippine nutrition survey.

[2] Based on sample means using time-series data from 1960-1988.

3.18 Bouis used a "characteristic food demand methodology" in estimating the elasticities. The method required a prespecification of some of the elasticities. Thus, the values for the rice and corn income elasticities were specified a priori. These estimates were obtained from an earlier study (Bouis, 1982) which was also based on household food expenditure survey data. Huang used the linear Almost Ideal System assuming weak separability of cereals from other foods and other goods.

3.19 The method used in this study allowed the estimation of all the elasticities for the commodities included in the system. Cereals are not assumed separable from other foods and other commodities.

3.20 The income elasticity for rice estimated in this study is slightly larger than those from Bouis and Huang. The estimates presented in Table 3 are based on the model with the proportion of "corn-consumers" in the total population included in the corn demand function. The income elasticities for corn estimated in this study are consistent with those derived from cross-section data, confirming that corn is an inferior good for human consumption in the Philippines. The estimate of the income elasticity of demand for wheat is also consistent with those from cross-section results, indicating that wheat is generally preferred over rice and corn.

## Conclusions and Policy Implications

5.1 The demand estimates presented in this paper provide new information about the characteristics of food demand in the Philippines. The food budget shares are seen to be strongly responsive to changes in relative prices and income. The results indicate that rice is still a normal good in the Philippines, although its income elasticity appears to have declined slightly over time. The magnitude of the estimated income elasticity for rice is larger than that found by Ito et al (1989). This provides support to the results of Bouis' analysis of household demand in the Philippines using cross-section data.

5.2 The estimated set of income and demand elasticities generates important policy implications. A general increase in per capita incomes or a shift in the income distribution skewed to high-income groups is likely to be accompanied by a relative increase in demand for commodities with high income elasticities, such as wheat, meat, and fruits and vegetables, relative to the staple foodstuffs.

5.3 The results suggest that policy makers should consider consumer adjustments to policy changes in their totality. The cross-price elasticity estimates suggest that a policy change targeted to changes in the price of a food item, such as rice, will have simultaneous impacts on consumption of related commodities. Based on the estimates of price and income elasticities presented in this paper, small changes in relative cereal prices can shift the pattern of food demand significantly.

5.4 The declining trend in the income elasticity of demand for rice and the long-term trend toward increasing diversity in food consumption have important implications for food policy, research, and investments in agriculture. Historically, agricultural development in the Philippines has concentrated on cereal production, particularly rice production. This emphasis is due to the importance of rice in food consumption and as a source of farmers incomes. In the long-term, income growth will fuel an expansion in demand for meat and livestock products. This and the accompanying diversification in food consumption and the shift from staple cereal to other grains will affect the overall pattern of agricultural production and consumption. The likely continued growth in meat consumption, particularly pork and poultry, will fuel the demand for cereals as livestock feed. This is already occurring in corn, soybeans, and wheat. Given these trends, an integrated approach to policy making and analyses is required. The piecemeal approach to policy has ignored the important linkages in the cereals, feed, and livestock-meat sectors. More importantly, an evaluation of economic effects of present pricing and trade policies, including tariff and import/export policies on cereal feeds, livestock and poultry sector is needed.

5.5 Policy formation without considering these linkages have adversely affected the performance of these sectors. For instance, the open import policy on wheat relative to corn has encouraged the utilization of wheat as livestock feed since wheat and corn are direct substitutes in animal feeding. As more wheat is diverted for animal feeds, wheat available for human consumption remain limited and prices of wheat flour products remain high. Meanwhile, the high degree of protection and the restrictive import policy on corn have entailed significant costs to the livestock-meat sector and have penalized consumers through high prices. The distortions in the corn sector have adversely affected the performance of the livestock-meat industry and may have limited the welfare gains from the liberalization of the wheat market. Thus, elimination of protection and trade barriers in the corn sector will improve the efficiency of the corn-livestock industry and will improve net welfare gains. This will also improve the efficiency and competitiveness of the wheat milling industry and should result in lower prices of wheat flour products, thus improving consumer welfare.

Given the high real cost of irrigation, and the relatively higher cost of rice imports compared to wheat, this may be a cost-effective policy option to meet food demand. [7]

5.6 Finally, the long-term trends in food consumption patterns should be considered in evaluating the costs and benefits of future irrigation investments in the rice sector. The trends in food demand suggest that as incomes rise, the share of rice in the diet will decline and the demand for meat and wheat products will increase. Since these trends will likely continue, the concern about future rice shortages and famine due to decline or lack of new irrigation investments may not be warranted. What will be more important is the alignment of food and trade policy to account for these trends and to improve food system performance. Given the high real cost of irrigation, further investments in irrigation should be carefully evaluated. More importantly, the role of improved trade policy should be evaluated in improving the food supply-demand balance.

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[7] Border prices for rice have generally been higher than domestic prices since the mid-1970s. In the IFPRI report on the Food Crop Sector, Rosegrant, et al (1987) calculate nominal protection rates for rice for the 1971 to 1985 period. On average, the nominal protection rate was +21% during rice importing years and -11% during years of surplus. Over the 1971-85 period, the average nominal rate of protection for rice was 5.6%.

# APPENDIX: MARSHALLIAN AND HICKSIAN OWN AND CROSS-PRICE ELASTICITIES, 1965-88

Table A1. Income Elasticities of Demand, 1965-1990.

| Year | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg. |
|---|---|---|---|---|---|---|
| 1965 | 0.4374 | -0.3405 | 0.2828 | 0.9461 | 1.0987 | 0.5736 |
| 1966 | 0.4136 | -0.2393 | 0.4820 | 0.9516 | 1.1003 | 0.5996 |
| 1967 | 0.4612 | -0.2946 | 0.5178 | 0.9506 | 1.0921 | 0.6351 |
| 1968 | 0.3129 | -0.3809 | 0.5409 | 0.9507 | 1.0820 | 0.6011 |
| 1969 | 0.2972 | -0.3175 | 0.5401 | 0.9481 | 1.0828 | 0.5881 |
| 1970 | 0.2254 | -0.2957 | 0.4580 | 0.9442 | 1.0693 | 0.6423 |
| 1971 | 0.3351 | -0.0754 | 0.5343 | 0.9473 | 1.0579 | 0.6539 |
| 1972 | 0.3484 | -0.0978 | 0.5155 | 0.9446 | 1.0525 | 0.7207 |
| 1973 | 0.3942 | -0.0899 | 0.5203 | 0.9507 | 1.0546 | 0.6629 |
| 1974 | 0.3988 | -0.2068 | 0.5285 | 0.9606 | 1.0514 | 0.7085 |
| 1975 | 0.4207 | -0.1662 | 0.4609 | 0.9485 | 1.0495 | 0.6929 |
| 1976 | 0.3850 | -0.1299 | 0.5611 | 0.9402 | 1.0538 | 0.7369 |
| 1977 | 0.2992 | -0.0398 | 0.4535 | 0.9329 | 1.0566 | 0.7259 |
| 1978 | 0.1950 | -0.1585 | 0.4265 | 0.9347 | 1.0605 | 0.7741 |
| 1979 | 0.1386 | -0.2644 | 0.4327 | 0.9440 | 1.0620 | 0.7766 |
| 1980 | 0.1196 | -0.4093 | 0.4388 | 0.9440 | 1.0586 | 0.8020 |
| 1981 | 0.0915 | -0.4239 | 0.4080 | 0.9436 | 1.0549 | 0.8078 |
| 1982 | 0.0958 | -0.4102 | 0.4358 | 0.9374 | 1.0543 | 0.7876 |
| 1983 | 0.0677 | -0.3976 | 0.2819 | 0.9355 | 1.0573 | 0.7967 |
| 1984 | 0.1399 | -0.4360 | 0.3050 | 0.9377 | 1.0590 | 0.7764 |
| 1985 | 0.2926 | -0.1020 | 0.2253 | 0.9251 | 1.0602 | 0.7558 |
| 1986 | 0.2491 | -0.2270 | 0.6000 | 0.9366 | 1.0550 | 0.7886 |
| 1987 | 0.1492 | -0.2815 | 0.3411 | 0.9394 | 1.0584 | 0.7906 |
| 1988 | 0.1573 | -0.4346 | 0.5158 | 0.9419 | 1.0568 | 0.8044 |
| 1989 | 0.2233 | -0.4180 | 0.5108 | 0.9482 | 1.0637 | 0.7837 |
| 1990 | 0.1840 | -0.7626 | 0.5073 | 0.9473 | 1.0614 | 0.7795 |
| At Sample Means | 0.2942 | -0.2124 | 0.4547 | 0.9438 | 1.0659 | 0.7255 |
| Average 1987-1990 | 0.1795 | -0.4545 | 0.4776 | 0.9444 | 1.0600 | 0.7900 |

Table A2. Rice Demand: Marshallian Own and Cross-Price Elasticities.

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | -0.3588 | 0.0696 | 0.1109 | 0.0207 | -0.0636 | -0.3215 |
| 1966 | -0.3328 | 0.0731 | 0.1163 | 0.0221 | -0.0664 | -0.3346 |
| 1967 | -0.3849 | 0.0669 | 0.1071 | 0.0202 | -0.0606 | -0.3067 |
| 1968 | -0.2227 | 0.0847 | 0.1367 | 0.0257 | -0.0767 | -0.3920 |
| 1969 | -0.2056 | 0.0871 | 0.1398 | 0.0261 | -0.0785 | -0.4012 |
| 1970 | -0.1271 | 0.0961 | 0.1535 | 0.0284 | -0.0853 | -0.4407 |
| 1971 | -0.2470 | 0.0858 | 0.1322 | 0.0246 | -0.0719 | -0.3779 |
| 1972 | -0.2616 | 0.0844 | 0.1295 | 0.0239 | -0.0696 | -0.3679 |
| 1973 | -0.3117 | 0.0783 | 0.1204 | 0.0227 | -0.0651 | -0.3441 |
| 1974 | -0.3167 | 0.0793 | 0.1195 | 0.0237 | -0.0641 | -0.3400 |
| 1975 | -0.3406 | 0.0759 | 0.1148 | 0.0215 | -0.0615 | -0.3281 |
| 1976 | -0.3015 | 0.0800 | 0.1225 | 0.0222 | -0.0659 | -0.3465 |
| 1977 | -0.2078 | 0.0891 | 0.1388 | 0.0249 | -0.0756 | -0.3954 |
| 1978 | -0.0939 | 0.1011 | 0.1593 | 0.0287 | -0.0874 | -0.4508 |
| 1979 | -0.0323 | 0.1071 | 0.1705 | 0.0315 | -0.0938 | -0.4822 |
| 1980 | -0.0114 | 0.1083 | 0.1743 | 0.0322 | -0.0953 | -0.4901 |
| 1981 | -0.0193 | 0.1117 | 0.1797 | 0.0332 | -0.0976 | -0.5050 |
| 1982 | -0.0146 | 0.1113 | 0.1790 | 0.0324 | -0.0970 | -0.5050 |
| 1983 | -0.1934 | 0.1315 | 0.2104 | 0.0381 | -0.1153 | -0.5951 |
| 1984 | -0.0337 | 0.1057 | 0.1696 | 0.0309 | -0.0932 | -0.4815 |
| 1985 | -0.2006 | 0.0893 | 0.1392 | 0.0247 | -0.0768 | -0.3974 |
| 1986 | -0.1530 | 0.0937 | 0.1500 | 0.0269 | -0.0807 | -0.4193 |
| 1987 | -0.0438 | 0.1057 | 0.1679 | 0.0307 | -0.0921 | -0.4749 |
| 1988 | -0.0526 | 0.1035 | 0.1674 | 0.0306 | -0.0909 | -0.4688 |
| 1989 | -0.1248 | 0.0955 | 0.1543 | 0.0288 | -0.0848 | -0.4342 |
| 1990 | -0.0819 | 0.0986 | 0.1620 | 0.0302 | -0.0888 | -0.4565 |
| At Sample Means | -0.2023 | 0.0882 | 0.1398 | 0.0258 | -0.0773 | -0.3983 |
| Average 1987-1990 | -0.0769 | 0.1007 | 0.1627 | 0.0301 | -0.0890 | -0.4580 |

Table A3. Corn Food Demand: Marshallian Own and Cross-Price Elasticities

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | 0.3052 | -0.0281 | 0.2166 | 0.7767 | 0.7488 | 0.0784 |
| 1966 | 0.2798 | -0.0483 | 0.1986 | 0.7191 | 0.6922 | 0.0735 |
| 1967 | 0.2974 | -0.0066 | 0.2070 | 0.7509 | 0.7238 | 0.0785 |
| 1968 | 0.3028 | -0.0586 | 0.2205 | 0.8010 | 0.7733 | 0.0820 |
| 1969 | 0.2878 | -0.0108 | 0.2104 | 0.7638 | 0.7378 | 0.0777 |
| 1970 | 0.2785 | -0.0057 | 0.2080 | 0.7505 | 0.7277 | 0.0790 |
| 1971 | 0.2039 | -0.2859 | 0.1477 | 0.5359 | 0.5210 | 0.0568 |
| 1972 | 0.1997 | -0.3028 | 0.1443 | 0.5226 | 0.5096 | 0.0588 |
| 1973 | 0.2042 | -0.2969 | 0.1455 | 0.5279 | 0.5135 | 0.0563 |
| 1974 | 0.1782 | -0.3851 | 0.1268 | 0.4616 | 0.4482 | 0.0511 |
| 1975 | 0.1887 | -0.3545 | 0.1338 | 0.4834 | 0.4716 | 0.0529 |
| 1976 | 0.1946 | -0.3271 | 0.1387 | 0.5036 | 0.4911 | 0.0578 |
| 1977 | 0.2272 | -0.1990 | 0.1669 | 0.6011 | 0.5863 | 0.0682 |
| 1978 | 0.2476 | -0.1093 | 0.1862 | 0.6699 | 0.6523 | 0.0808 |
| 1979 | 0.2675 | -0.0293 | 0.2032 | 0.7324 | 0.7116 | 0.0886 |
| 1980 | 0.2973 | -0.0801 | 0.2264 | 0.8163 | 0.7940 | 0.1031 |
| 1981 | 0.2990 | -0.0910 | 0.2291 | 0.8246 | 0.8033 | 0.1054 |
| 1982 | 0.2963 | -0.0807 | 0.2266 | 0.8158 | 0.7958 | 0.1006 |
| 1983 | 0.2875 | -0.0712 | 0.2258 | 0.8083 | 0.7878 | 0.1013 |
| 1984 | 0.3039 | -0.1002 | 0.2319 | 0.8308 | 0.8089 | 0.1006 |
| 1985 | 0.2404 | -0.1520 | 0.1783 | 0.6364 | 0.6205 | 0.0749 |
| 1986 | 0.2651 | -0.0576 | 0.1950 | 0.7097 | 0.6922 | 0.0877 |
| 1987 | 0.2716 | -0.0165 | 0.2067 | 0.7416 | 0.7220 | 0.0919 |
| 1988 | 0.3045 | -0.0991 | 0.2295 | 0.8306 | 0.8088 | 0.1054 |
| 1989 | 0.3047 | -0.0866 | 0.2269 | 0.8220 | 0.7976 | 0.1005 |
| 1990 | 0.3759 | -0.3467 | 0.2821 | 1.0216 | 0.9921 | 0.1240 |
| At Sample Means | 0.2646 | -0.0686 | 0.1946 | 0.7022 | 0.6815 | 0.0795 |
| Average 1987-1990 | 0.3099 | -0.1142 | 0.2332 | 0.8425 | 0.8191 | 0.1042 |

Table A4. Wheat Demand: Marshallian Own and Cross-Price Elasticities.

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | 1.5318 | 0.7776 | -0.2806 | -0.8682 | 0.7884 | 0.1021 |
| 1966 | 1.1054 | 0.5611 | -0.4798 | -0.6267 | 0.5694 | 0.0741 |
| 1967 | 1.0308 | 0.5225 | -0.5156 | -0.5834 | 0.5302 | 0.0696 |
| 1968 | 0.9767 | 0.4979 | -0.5387 | -0.5555 | 0.5053 | 0.0657 |
| 1969 | 0.9779 | 0.4984 | -0.5379 | -0.5566 | 0.5061 | 0.0656 |
| 1970 | 1.1508 | 0.5874 | -0.4558 | -0.6563 | 0.5974 | 0.0784 |
| 1971 | 0.9912 | 0.5023 | -0.5321 | -0.5637 | 0.5142 | 0.0676 |
| 1972 | 1.0317 | 0.5225 | -0.5132 | -0.5866 | 0.5356 | 0.0722 |
| 1973 | 1.0229 | 0.5173 | -0.5181 | -0.5804 | 0.5300 | 0.0699 |
| 1974 | 1.0056 | 0.5072 | -0.5263 | -0.5696 | 0.5213 | 0.0699 |
| 1975 | 1.1506 | 0.5805 | -0.4587 | -0.6524 | 0.5963 | 0.0794 |
| 1976 | 0.9357 | 0.4730 | -0.5588 | -0.5316 | 0.4850 | 0.0659 |
| 1977 | 1.1622 | 0.5906 | -0.4513 | -0.6623 | 0.6035 | 0.0816 |
| 1978 | 1.2169 | 0.6207 | -0.4243 | -0.6950 | 0.6329 | 0.0881 |
| 1979 | 1.2024 | 0.6146 | -0.4305 | -0.6868 | 0.6259 | 0.0873 |
| 1980 | 1.1892 | 0.6087 | -0.4366 | -0.6795 | 0.6195 | 0.0881 |
| 1981 | 1.2538 | 0.6422 | -0.4058 | -0.7168 | 0.6540 | 0.0934 |
| 1982 | 1.1952 | 0.6120 | -0.4336 | -0.6836 | 0.6234 | 0.0875 |
| 1983 | 1.5180 | 0.7789 | -0.2797 | -0.8701 | 0.7930 | 0.1122 |
| 1984 | 1.4731 | 0.7540 | -0.3029 | -0.8419 | 0.7671 | 0.1069 |
| 1985 | 1.6471 | 0.8378 | -0.2232 | -0.9392 | 0.8549 | 0.1176 |
| 1986 | 0.8497 | 0.4332 | -0.5977 | -0.4846 | 0.4419 | 0.0621 |
| 1987 | 1.3968 | 0.7139 | -0.3390 | -0.7981 | 0.7274 | 0.1024 |
| 1988 | 1.0266 | 0.5253 | -0.5136 | -0.5863 | 0.5347 | 0.0762 |
| 1989 | 1.0385 | 0.5306 | -0.5086 | -0.5920 | 0.5395 | 0.0756 |
| 1990 | 1.0452 | 0.5356 | -0.5051 | -0.5964 | 0.5437 | 0.0760 |
| At Sample Means | 1.1594 | 0.5904 | -0.4525 | -0.6602 | 0.6012 | 0.0814 |
| Average 1987-1990 | 1.1081 | 0.5668 | -0.4754 | -0.6325 | 0.5766 | 0.0812 |

Table A5. Meat Demand: Marshallian Own and Cross-Price Elasticities.

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | 0.1172 | 1.3488 | -0.4311 | -1.1180 | 0.6531 | 0.2769 |
| 1966 | 0.1053 | 1.2126 | -0.3875 | -0.9041 | 0.5871 | 0.2490 |
| 1967 | 0.1076 | 1.2372 | -0.3954 | -0.9428 | 0.5990 | 0.2541 |
| 1968 | 0.1069 | 1.2347 | -0.3946 | -0.9389 | 0.5978 | 0.2535 |
| 1969 | 0.1124 | 1.2991 | -0.4151 | -1.0400 | 0.6289 | 0.2667 |
| 1970 | 0.1206 | 1.3965 | -0.4463 | -1.1929 | 0.6760 | 0.2868 |
| 1971 | 0.1143 | 1.3202 | -0.4218 | -1.0727 | 0.6388 | 0.2711 |
| 1972 | 0.1203 | 1.3884 | -0.4436 | -1.1798 | 0.6717 | 0.2853 |
| 1973 | 0.1070 | 1.2336 | -0.3941 | -0.9367 | 0.5969 | 0.2533 |
| 1974 | 0.0857 | 0.9876 | -0.3155 | -0.5504 | 0.4778 | 0.2029 |
| 1975 | 0.1120 | 1.2894 | -0.4120 | -1.0242 | 0.6238 | 0.2649 |
| 1976 | 0.1299 | 1.4982 | -0.4786 | -1.3520 | 0.7249 | 0.3080 |
| 1977 | 0.1453 | 1.6796 | -0.5367 | -1.6370 | 0.8127 | 0.3452 |
| 1978 | 0.1412 | 1.6349 | -0.5225 | -1.5671 | 0.7912 | 0.3363 |
| 1979 | 0.1210 | 1.4023 | -0.4482 | -1.2020 | 0.6787 | 0.2885 |
| 1980 | 0.1209 | 1.4019 | -0.4481 | -1.2014 | 0.6785 | 0.2886 |
| 1981 | 0.1217 | 1.4122 | -0.4514 | -1.2176 | 0.6834 | 0.2908 |
| 1982 | 0.1352 | 1.5682 | -0.5012 | -1.4626 | 0.7589 | 0.3227 |
| 1983 | 0.1388 | 1.6136 | -0.5158 | -1.5339 | 0.7810 | 0.3322 |
| 1984 | 0.1347 | 1.5610 | -0.4990 | -1.4512 | 0.7555 | 0.3212 |
| 1985 | 0.1623 | 1.8764 | -0.5997 | -1.9461 | 0.9081 | 0.3859 |
| 1986 | 0.1373 | 1.5884 | -0.5075 | -1.4941 | 0.7687 | 0.3269 |
| 1987 | 0.1310 | 1.5183 | -0.4853 | -1.3841 | 0.7348 | 0.3125 |
| 1988 | 0.1256 | 1.4557 | -0.4652 | -1.2859 | 0.7045 | 0.2997 |
| 1989 | 0.1120 | 1.2962 | -0.4143 | -1.0356 | 0.6274 | 0.2667 |
| 1990 | 0.1139 | 1.3197 | -0.4218 | -1.0727 | 0.6388 | 0.2716 |
| At Sample Means | 0.1218 | 1.4075 | -0.4498 | -1.2100 | 0.6812 | 0.2893 |
| Average 1987-1990 | 0.1201 | 1.3914 | -0.4447 | -1.1850 | 0.6735 | 0.2864 |

Table A6. Fish Demand: Marshallian Own and Cross-Price Elasticities.

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | -0.4533 | 1.2693 | 0.3782 | 0.6399 | -0.5622 | 0.7236 |
| 1966 | -0.4602 | 1.2892 | 0.3840 | 0.6500 | -0.5867 | 0.7349 |
| 1967 | -0.4231 | 1.1842 | 0.3527 | 0.5971 | -0.4574 | 0.6749 |
| 1968 | -0.3759 | 1.0546 | 0.3141 | 0.5317 | -0.2977 | 0.6011 |
| 1969 | -0.3793 | 1.0642 | 0.3169 | 0.5365 | -0.3096 | 0.6066 |
| 1970 | -0.3172 | 0.8907 | 0.2653 | 0.4490 | -0.0961 | 0.5076 |
| 1971 | -0.2655 | 0.7443 | 0.2218 | 0.3754 | -0.0840 | 0.4243 |
| 1972 | -0.2406 | 0.6742 | 0.2009 | 0.3400 | -0.1702 | 0.3842 |
| 1973 | -0.2505 | 0.7018 | 0.2091 | 0.3540 | -0.1363 | 0.4001 |
| 1974 | -0.2356 | 0.6598 | 0.1966 | 0.3330 | -0.1878 | 0.3761 |
| 1975 | -0.2272 | 0.6359 | 0.1895 | 0.3208 | -0.2173 | 0.3625 |
| 1976 | -0.2469 | 0.6915 | 0.2060 | 0.3488 | -0.1488 | 0.3940 |
| 1977 | -0.2591 | 0.7269 | 0.2166 | 0.3665 | -0.1055 | 0.4141 |
| 1978 | -0.2767 | 0.7772 | 0.2316 | 0.3918 | -0.0437 | 0.4425 |
| 1979 | -0.2837 | 0.7973 | 0.2375 | 0.4019 | -0.0190 | 0.4538 |
| 1980 | -0.2682 | 0.7538 | 0.2246 | 0.3800 | -0.0726 | 0.4289 |
| 1981 | -0.2511 | 0.7059 | 0.2103 | 0.3558 | -0.1316 | 0.4016 |
| 1982 | -0.2484 | 0.6983 | 0.2080 | 0.3519 | -0.1410 | 0.3974 |
| 1983 | -0.2619 | 0.7370 | 0.2196 | 0.3715 | -0.0933 | 0.4193 |
| 1984 | -0.2701 | 0.7591 | 0.2262 | 0.3826 | -0.0662 | 0.4320 |
| 1985 | -0.2759 | 0.7740 | 0.2307 | 0.3901 | -0.0476 | 0.4407 |
| 1986 | -0.2520 | 0.7075 | 0.2107 | 0.3567 | -0.1295 | 0.4027 |
| 1987 | -0.2674 | 0.7513 | 0.2238 | 0.3787 | -0.0757 | 0.4275 |
| 1988 | -0.2601 | 0.7308 | 0.2176 | 0.3683 | -0.1010 | 0.4157 |
| 1989 | -0.2918 | 0.8196 | 0.2441 | 0.4132 | -0.0083 | 0.4664 |
| 1990 | -0.2808 | 0.7889 | 0.2349 | 0.3976 | -0.0296 | 0.4489 |
| At Sample Means | -0.3020 | 0.8473 | 0.2524 | 0.4272 | -0.0426 | 0.4826 |
| Average 1987-1990 | -0.2745 | 0.7711 | 0.2297 | 0.3887 | -0.0513 | 0.4388 |

Table A7. Fruits & Vegetables: Marshallian Own and Cross-Price Elasticities.

| Year | With Respect To The Price Of | | | | | |
|---|---|---|---|---|---|---|
| | Rice | Corn | Wheat | Meat | Fish | Fruits & Veg |
| 1965 | -1.1779 | 0.0629 | 0.0261 | 0.1511 | 0.4005 | -0.2247 |
| 1966 | -1.1069 | 0.0595 | 0.0250 | 0.1422 | 0.3761 | -0.1505 |
| 1967 | -1.0072 | 0.0540 | 0.0229 | 0.1295 | 0.3429 | -0.0488 |
| 1968 | -1.1054 | 0.0587 | 0.0251 | 0.1416 | 0.3753 | -0.1462 |
| 1969 | -1.1416 | 0.0609 | 0.0260 | 0.1461 | 0.3874 | -0.1832 |
| 1970 | -0.9928 | 0.0529 | 0.0223 | 0.1267 | 0.3371 | -0.0284 |
| 1971 | -0.9584 | 0.0529 | 0.0218 | 0.1227 | 0.3268 | -0.0050 |
| 1972 | -0.7733 | 0.0428 | 0.0175 | 0.0989 | 0.2640 | -0.1960 |
| 1973 | -0.9324 | 0.0517 | 0.0212 | 0.1197 | 0.3186 | -0.0305 |
| 1974 | -0.8062 | 0.0454 | 0.0183 | 0.1040 | 0.2757 | -0.1610 |
| 1975 | -0.8486 | 0.0476 | 0.0191 | 0.1089 | 0.2905 | -0.1165 |
| 1976 | -0.7279 | 0.0405 | 0.0167 | 0.0931 | 0.2487 | -0.2422 |
| 1977 | -0.7597 | 0.0414 | 0.0170 | 0.0968 | 0.2589 | -0.2108 |
| 1978 | -0.6273 | 0.0338 | 0.0140 | 0.0798 | 0.2132 | -0.3486 |
| 1979 | -0.6207 | 0.0331 | 0.0139 | 0.0791 | 0.2107 | -0.3558 |
| 1980 | -0.5503 | 0.0291 | 0.0123 | 0.0701 | 0.1869 | -0.4284 |
| 1981 | -0.5344 | 0.0282 | 0.0119 | 0.0681 | 0.1816 | -0.4450 |
| 1982 | -0.5904 | 0.0312 | 0.0132 | 0.0751 | 0.2007 | -0.3873 |
| 1983 | -0.5660 | 0.0299 | 0.0124 | 0.0718 | 0.1920 | -0.4133 |
| 1984 | -0.6212 | 0.0328 | 0.0137 | 0.0790 | 0.2111 | -0.3552 |
| 1985 | -0.6769 | 0.0367 | 0.0149 | 0.0861 | 0.2305 | -0.2962 |
| 1986 | -0.5865 | 0.0314 | 0.0135 | 0.0747 | 0.1997 | -0.3900 |
| 1987 | -0.5818 | 0.0310 | 0.0129 | 0.0740 | 0.1977 | -0.3958 |
| 1988 | -0.5435 | 0.0287 | 0.0123 | 0.0692 | 0.1848 | -0.4351 |
| 1989 | -0.6003 | 0.0318 | 0.0136 | 0.0767 | 0.2040 | -0.3760 |
| 1990 | -0.6123 | 0.0319 | 0.0138 | 0.0782 | 0.2081 | -0.3640 |
| At Sample Means | -0.7609 | 0.0409 | 0.0171 | 0.0972 | 0.2588 | -0.2096 |
| Average 1987-1990 | -0.5833 | 0.0308 | 0.0131 | 0.0744 | 0.1982 | -0.3940 |

## V. References

Attfield, C.L.F. (1985), "Homogeneity and Endogeneity in Systems Demand Equations", Journal of Econometrics 27:197-209.

Baldwin, M.A., M. Hadid, and G.D.A. Phillips (1983), "The Estimation and Testing of a System of Demand Equations for the U.K.", Applied Economics 15:81-90.

Bouis, H.E. (1989), Prospects for Rice Supply and Demand Balances in Asia. Final Report submitted to Rockefeller Foundation, International Food Policy Research Institute, Washington, D.C.

Chambers, M. (1990), "Forecasting with Demand Systems", Journal of Econometrics, 44:363-376.

Deaton, A.S. and J. Muellbauer (1980), "An Almost Ideal Demand System." The American Economic Review, 70:312-329.

Huang, J. (1990), Changing Consumption Patterns and Demand for Cereal Grains in Asia, Unpublished Ph.D. Dissertation, University of the Philippines at Los Banos, Philippines.

Ito, S., E. Peterson, and W. Grant (1989), "Rice in Asia: Is It Becoming an Inferior Good"? Amer. J. Agr. Econ., 71:32-42.

Meisner, J.F. (1979), "The Sad Fate of the Asymptotic Slutsky Symmetry Test for Large Systems", Economic Letters, 2:231-233.

Rosegrant, M., L. Gonzales, H. Bouis, and J.Sison, "Price and Investment Policies for Food Crop Sector Growth in the Philippines," IFPRI, January 20, 1987.

Stone, J.R.N. (1954), "Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand." Economic Journal, 64:511-527.

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